Innovation Policies and Technology Parks in China and Taiwan: An Evolutionary Approach

Tonatiuh Najera Ruiz, *SolBridge International School of Business*

***Abstract*— Innovation and technology development are closely related to economic development. Governments in many countries have launched a series of policies to encourage innovation and the development of technology as a mean to generate economic development. These initiatives require coordination and participation of a range of stakeholders, including the government, research centers, universities and companies. This paper shows the development of innovation policies in China and Taiwan as well as the different adaptations that have been made to their national innovation systems (NIS) in the last 50 years, as well as inferred opportunities for technological cooperation beyond borders. Even though both countries started from very different conditions, they both have some common elements.**

***Index Terms*— innovation policies, national innovation systems, technology parks, China, Taiwan, R&D**

I. INTRODUCTION

Innovation and technological progress are deeply interrelated with economic development. How to formulate policies that operate these relationships is one of the most important questions of any government, as in most countries they play a key role in driving technological progress and in creating an environment for innovation by providing the infrastructure and establishing a series of policies of science and technology [1]. The challenges faced by nations at different stages of economic development are diverse. Some Asian economies, have let economic growth been lead by technological innovation by transforming their economies from merely factor-driven in the 1960's and 1970's. Countries like South Korea, Taiwan and Singapore are the best examples of this economic development. However, they are now facing increasing competition from new high-tech economies and regions, such as Israel, Ireland, Shanghai and Beijing in China, as well as Bangalore in India [1].

In fostering innovation and technological change, governments can play two different roles: 1) they can structure an enhancing policy environment, provide an adequate technological infrastructure, and assist in private-sector coordination, and; 2) directly participate in market processes by using a series of different instruments. Additionally, investment in education to develop human capital is needed [1].

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Tonatiuh Najera Ruiz is Associate Professor at SolBridge International School of Business, Republic of Korea. e-mail: tnajera@solbridge.ac.kr).

The key task that many governments are facing now is to set up policies that stimulate firms and institutions (such as universities and R&D centers) to engage in technological development and to help enhance firm specific and national technological capabilities, including production, investment, and innovation [1]. Incorporating innovation into economic development policies has become a necessity for the regions to compete in a globalized world with little to none restrictions to capital and to the production factors movement. The creation of collaborative knowledge networks between the government, the companies and the universities becomes fundamental for the success of innovation clusters [2]. Government, through open policies and programs can encourage the creation of knowledge by funding both basic and applied research initiatives, sharing resources, and facilitating knowledge and technological spillovers [1].

The importance of innovation clusters and technology parks has been stated frequently in the recent literature [3] – [6]. Not only for the employment generation or the technological spillovers, but for its implications on the generation of policies of regional development, and the creation of a strong infrastructure in several dimensions. As the role of innovation has been increasingly recognized as a key for economic development, it has become much more evident the importance of policy studies for the development of science and technology. However, innovation is subject to a number of capital and infrastructure challenges that are needed for its development. This is especially true for developing countries, where such policies can't be equal to those of the developed nations [7].

Most studies on innovation policies have taken two paths: The national innovation systems and the triple helix system [8]. Research on NIS has focused on the multiple actors involved in the implementation of policies: government, universities, industry and capital, to explain innovation [7], [9] – [10], for its part, the model of the triple helix system proposes that universities, government and industry interact frequently and result in hybrid forms of work organization [8], [11] – [13] analyses the "triple helix" model of these collaboration between universities, industry and government. She claims that the third mission of the universities imply that the academic production must be focused on the government needs and the use of funding organizations. [13] states that the third function of the universities consists on contributing to the social and to the economic development through knowledge based innovations. On this regard, [14] adds that researchers seem to be highly motivated by the impact of their results on the local economy and community. On this context, the third

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academic revolution is driven by the entrepreneurial universities, which assume the responsibility of creating new ventures on their laboratories and on their facilities, finding strategic niches and raising a new kind of academician: the scientific-entrepreneur [11].

One of the approaches to developing technological capability is the followers' strategy. This model emphasizes the need for human resources to allow an economy or a region to 'shift' from labor-intensive operation found in the early stages of the product cycle to more skilled-intensive activities at higher levels in the international division of labor [15]. Japan was the first country to follow this strategy and was later followed by South Korea and Taiwan. In the initial stage, implementation of imported foreign technology and dependence on foreign experts prevailed. On the second stage, assimilation of technology, permitted product diversification based on indigenous capabilities. The third stage comprised improvement of technology to enhance competitiveness of both product and processes in international markets [16]. Along with this phase is the development of local scientific and engineering talent. The fourth stage emphasized the development of an independent innovative capability [17] – [18].

At the end of the Chinese civil war, Taiwan and China separated politically and economically. The former adopting a western economic model of free market, while the later implemented communism and a centrally planned economy [10]. These differences in economic and political ideologies led to big differences in their NIS and their performances. Taiwan's economy clearly surpassed that of China from the 1950s through the 1980s. However, the implementation of economic reforms since the late 1970s has seen China become a rapidly developing economy enjoying high economic growth rates [10]. Increasing business relations among the two sides is forcing both governments to open faster on a series of policies that facilitate and foster this economical exchange, the main result of the large and increasingly business oriented interaction between Taiwan and China is increased economic growth for both sides. As this activity becomes more knowledge-intensive, economic growth becomes increasingly dependent on the accumulation of knowledge, which itself mainly results from innovations [10].

China and Taiwan will continue to influence and even cooperate with each other in science and technology [10]. This study presents the evolution of innovation policies implemented in both countries that have led to strong economic growth. The rest of the paper is divided as follows: section 2 discusses the literature on innovation policies; section 3 presents innovation policies implemented in China; section 4 shows the evolution of Taiwan's innovation policies; section 5 discusses similarities and differences in the innovation systems of these two countries, and finally, section 6 concludes with a series of afterthoughts.

II. On innovation policies

Technological innovation has always been at the center of the economic development. Innovation depends on the conditions in the economy, the public policies, education, and infrastructure. Efficient innovation policies cover the overall eco-system, which is more than science and technology, and commit many areas from the public administration [19]. Governments can facilitate the articulation and implementation of innovative initiatives, procuring basic technical and financial support. Public departments can reduce obstacles to innovation by providing regulatory and legal frameworks. Government-sponsored research and development structures can respond to the needs and demands of their communities, and finally, the educational system can help form a much-needed skilled human capital [20].

Traditionally, governments have played an important role in promoting the creation of innovation and technology, sometimes by directly supporting the development of technologies or more indirectly by creating a climate favorable to innovation [21], [9], [22]. On this regard, every society must find the ways to promote innovation that fits to its needs and capabilities [20]. The innovation climate is largely determined by its overall macroeconomic, business, and governance conditions [20]. Innovation processes grow and develop within what are called Innovation Systems [22].

The concept of a national innovation system encompasses the set of political and other factors that determine a society's ability to define creatively and achieve increasingly ambitious cultural, social and economic goals [19]. In contemporary economic thinking, an Innovation System is defined as the purposeful combination of market and non-market mechanisms to optimize the production, deployment and use of new knowledge for sustainable growth, through institutionalized processes in the public and private sector. National innovation systems are crucial for the description of the institutions that are devoted to innovation. The cores of these institutions are those actors that produce, adapt and diffuse new technical knowledge [9]. Sectoral innovation systems (SIS) involve a multidimensional, integrated and dynamic view of sectors [23]. A Sectoral system is built upon a set of products and economic agents involved in market and non-market interactions for the creation, sale and production of those products. The system has specific characteristics within its knowledge base, technology, input and demand. The interactions are shaped by the institutions and the change within the sectoral system arises from co-evaluation of its elements [24]. Since the sectors differ from country to country and also within the country, there is a large variety of SIS.

Innovation policy requires action in many different areas, such as education, investment, finance, and decentralization, among others. In order to create a productive and efficient innovation environment, it is necessary to generate the right combination of interventions in these diverse domains [20]. This approach to innovation policy explicitly recognizes the role of proactive and comprehensive government policies in establishing the overall framework and in fostering interaction among the actors, including different parts of government [25]. It depends on the establishment of efficient government machinery able to ensure the needed coordination of the efforts. To make an innovation system work, many different aspects have to be included: science, both hard and soft, product development, with technological and social aspects and, entrepreneurship, which plays a vital role. There cannot exist any innovation without any entrepreneurship [26]. These factors create together a system in which the change process is cyclic in nature [26]. [27] state that there are three main features to take into account on the implementation of an innovation system: 1) policies concerning the transformation pressure (competition policy, trade policy, and the position of general economic policy); 2) policies concerning the ability to innovate and handle change (human resource development and innovation policy), and; 3) policies constructed so that they are able to take care of the misfortunes in the transformation process (social, labor market and regional policies with redistribution objectives).

III. Evolution of China's innovation policies

The Chinese model of growth and development has produced impressive results in a relatively very short period of time, but China's income per capita is still low [28]. To date, China has largely relied on the supply of foreign technology, but it is now boosting investment in science and technology and has taken steps towards building a so-called high-performing "enterprise-based innovation system" [28], [21].

Recent policy initiatives show China's determination to strength investment in science and technology and build a solid national innovation system [21]. The 2006 Medium- to Long-Term Strategic Plan for the Development of Science and Technology (MLP) sets out the key objectives and priorities in science and technology [21]. The overarching goal is to make China an innovation-oriented society by the year 2020 and one of the world's leading innovation economies by 2050 [21]. It emphasizes the need to develop capabilities for indigenous innovation.

From the perspective of innovation policies, China's post-1978 era can be divided into five periods, marked by five significant national Science and Technology (S&T) conferences, held in 1978, 1985, 1995, 1999 and 2006 respectively (see table 1), during which strategic decisions were made to re-shape previous policies and initiatives (OECD, 2008). This section will follow the discussion of the evolution of China's innovation policies using the first period between 1980 and 1984; the second, between 1985 and 1994; the third, between 1995 and 2005; and the fourth, after 2006 as in [21].

Table 1. China's National Science and Technology Conferences

Time	Name	Significance
Mar-78	National Science Conference	Deng Xiaoping brought forward the famous thesis that S&T is a productive force, intellectuals are part of the working class, and S&T is the key to China's "Four Modernizations" drive.
Mar-75	National Science and Technology Working Conference	Deng Xiaoping made an important speech "The Reform of the S&T System Is to Liberate the Productive Force." The Chinese People's Political Consultative Conference (CCPCC) issued the "Decision on the Reforms of the S&T System." Afterwards, China set the main task to enhance the economic orientation of the S&T system.
May-95	National Science and Technology Conference	The strategy of "revitalizing the nation through the science, technology and education" was put forward and CCPCC issued the "decision on accelerating the progress of science and technology," advocating that economic development should rely on the progress of S&T.
Aug-99	National Conference on Technological Innovation	CCPCC and the State Council issued the "decision on strengthening the technological innovation, developing the high technology and realizing industrialization," calling for the construction of a national innovation system and speeding-up the industrialization of the S&T achievements.
Jan-06	National Science and Technology Conference	CCPCC and the State Council issued "Medium- and Long-Term Plan for the Development of Science and Technology (2006–2020)" to turn China into an "innovation-oriented country" by 2020 through building an indigenous innovation capability.

Source: OECD(2008)

A. *The 1980-1984 period*

During this period, only a few innovation policies were initiated. It started with a general renewal of China's S&T system. These years are described by the initiation of various national S&T programs. Many of these were run by either the State Planning Commission (SPC) or the State Economic Commission (SEC). During this period, it was the SPC and the SEC that set the agenda for China's S&T development, controlled and allocated resources for technological development activities, and administered S&T programs while the State Science and Technology Commission (SSTC) was only a background player [21].

B. The 1985-1994 period

The main focus of innovation policies during this period was on S&T and industrial policies. Also, the first fiscal policy was issued. The State Council introduced a series of S&T policies designed to reform the S&T system to fit the demands of economic development, to create a macroeconomic environment more conducive for S&T development, and to lay out the contours for a new and more competitive business environment [29].

As a result, high-tech companies emerged, and in 1988, the State Council formally approved setting up the Beijing Experimental Zone for New Technology and Industrial Development, now known as the Zhongguancun Science Park, which was given preferential policies on taxes, loans, and personnel mobility and recruitment to support its development. Additionally, the "Announcement on the Approval of National High- and New-Technology and Industrial Development Zones and Related Policies and Regulations," was issued approving another 26 national high-tech parks (as of now, China has a total of 53 such at the national level, and more than 50 at the provincial level) [5], [30]. The most noticeable of these programs is the State High-Tech R&D Program, also known as the 863 Program, launched in March 1986, to monitor high-tech trends in the world and make efforts to develop China's own high-tech industries [28]. Other programs also covered a wide spectrum of the S&T and R&D activities (from basic and applied research and development to commercialization).

C. The 1995 – 2005 period

During this period, China's innovation policies expanded existing S&T and industrial policies. Additionally, on this period financial, tax, and fiscal policies were also introduced, and a series of laws to nurture an environment for conducting business activities in China were passed. Additionally, S&T policy was directed toward stimulating broad institutional reforms at government-affiliated R&D institutions. Also, policies focused on the conversion of S&T achievements started to appear. Support for private S&T enterprises became one of the main points of Chinese innovation policies, and sector-oriented industrial policies were used to promote innovation. In particular, the new policies covered venture capital mechanisms for supporting the software industry, preferential tax rates for enterprises producing software and integrated circuits, support for fund raising through public listing of qualified software companies, and measures encouraging the establishment of software ventures. There also were provisions encouraging higher levels of foreign investment as part of the overall development strategy for these two sectors [21].

D. The MLP implementation period

The MLP plan, released in January 2006, committed to the promotion of indigenous innovation and to position new science based industries. With this plan, China stated its intention to become an innovation-oriented society by the year 2020 and a world leader in science and technology by 2050 [31]. In order to expedite the innovation process, the MLP departed from the prevailing pattern of innovation policy-making, and provided an adequate coordination in the area of policy implementation. A number of S&T, industrial, financial, tax and fiscal policies were issued (see table 2).

Table 2. Policies issued under the MLP

Policy category	Number of agencies				% Policies
	1	2	3 or more	Total	
S&T	16	10	11	37	46.8
Industrial	6	2	11	19	24.1
Financial	5	3	1	9	11.4
Tax	0	6	3	9	11.4
Fiscal	5	0	0	5	6.3
Total	32	21	26	79	100
% agencies	40.5	26.6	32.9	100	

Source: MOST (2009).

S&T policies represented 46.8% of the total policies. With regard to investment in S&T, one policy calls for better management of the funding aspects of the national S&T programs such as the 863 Program, the State Basic Research and Development Program, also known as the 973 Program, and the State Key Technologies R&D Program. S&T policies also included attraction of high-end talent from overseas, postdoctoral fellowships, continuous education for professionals, the nurturing of practitioners in rural areas, and so on. On the education side, policies were formulated on sending students and scholars abroad using government funds, enhancing research-oriented universities, supporting key disciplines, and opening of learning institutions to society for the purpose of popularization. National engineering centers and laboratories, nationally certified enterprise engineering centers, certification of university high-tech parks at the national level, and key national laboratories established at transformed R&D institutes are among the main issues regarding the infrastructure for supporting S&T advance and innovation [31].

Industrial policies emphasize the building up of an indigenous innovation capability, and encourage innovation based on the assimilation of imported technology. There are even policies that specify priority technologies to be imported. Industrial policy also targets the talent issue, especially the shortage of key personnel in the areas of critical importance to the nation, the attraction of talent from overseas, and the evaluation and reward of personnel in central government controlled R&D institutes, design institutes, and enterprises [31].

Tax and financial policies contain nine initiatives each. Tax policies include preferential treatment for imports of equipment for scientific research and teaching, venture capital investment, enterprises engaged in innovation activities, university high-tech parks, incubators for S&T enterprises, and the provision of innovation funds for S&T-oriented SMEs. Financial policies, on the other hand, guide the establishment of innovation funds for S&T-oriented SMEs, support for national key S&T programs, and commit to the establishment and operation of an active IPR exchange market [31].

Finally, fiscal policies provide rules regarding government procurement, especially related to indigenously innovated products [31].

A. *Science and Technology Parks in China*

The Chinese government started the Torch program in the early 1990s to promote science and technology transfer through the concentration of high-tech companies in technology parks. These facilities were expected to expedite adoption and diffusion of technology and to create synergies among the academic and financial institutions and corporations within or near the park [5]. These parks offer various incentives to promote investment and new firm formation. Among these, new firms are exempted from corporate income tax for two years; license is waived for the import of materials and parts used in producing goods for export; a portion of the firm's revenue from technology transfer is tax exempted; intangible assets such as intellectual property can be factored into a company's registered capital, among others [5]. Firms are required to have a high, new-technology nature, and must be certified by a government agency every year in order to maintain benefits [32].

In March 1991, the State Council approved the establishment of 27 technology parks, followed by another 25 in the next year. The establishment of the Yanglin Agricultural Technology Park in 1997 brings the total number of national technology parks to 53. In the meantime, a large number of technology parks (over 50) have been established by various levels of local government under different regulations and S&T reach [5].

Technology parks have grown at a stunning pace. In eight years, technology parks' share of their host city's industrial output increased from 2% to nearly one third; labor productivity quadrupled; and the number of firms in the parks has more than tripled [32], [5]. As of 2000, Beijing had by far the largest number of firms in the park, 6,181 versus Shanghai's 438, although its average labor productivity is less than half of that of Shanghai. Both Beijing and Shanghai possess tremendous educational resources as measured by university enrolment [5].

However, in terms of the effectiveness of these parks, there are some contrasting results. On the one hand, [5] found that the relative size of a technology park in a host city raises the income per capita growth, and that establishing technology parks as a regional development policy has achieved to some extent, its objective of raising economic growth in less developed regions. On a different studio, [32] find that negative congestion effects in the parks outweigh positive agglomeration effects. The authors discuss that this is the result of inefficient incentives that attract companies to the park that get little to no value from the agglomeration effects, such as the availability of academic resources of the nearby universities.

IV. Evolution of Taiwan's innovation policies

Since the 1950s Taiwan's economic structure has undergone gradual reconfiguration. Until the beginning of the 21st century, five important stages of innovation policies can be identified that traced the path of growth and innovation [8], [33] – [34].

The first of these initiatives was the very ambitious land reform program (1949-52), which promoted social and political stability and increased agricultural production. With this larger output, raw materials for exports could be imported, and foreign currency earned to fund imports of machinery, equipment, and industrial raw materials [33].

The next period (1953-57) was characterized by import-substituting industrialization, by which the government attempted to develop industrial activity as the base for economic self-sufficiency. The government invested heavily in infrastructure, and quantitative restrictions, along with tariff rates, protected domestic consumer goods from foreign competition. To take advantage of abundant labor, light industries were subsidized. A distinctive feature of Taiwan's development was a heavy direct involvement in production through state ownership, on which the state played the initiating role [33].

During the export promotion period (1958-72), the government shifted to a policy of outward orientation and export development. Tariffs and import controls were gradually reduced, especially for inputs to export. Some industries were identified as promising industries for development and export promotion [35].

As a response to the profound impact of the 1973-74 oil crisis on the Taiwanese economy, a new development policy, called industrial consolidation and new export growth (1973-80) was implemented. This time, the plan focused on the development of capital-intensive industries to increase production of raw materials and semi manufactures for the use of the export industries. Additionally, the government also addressed how industrial sectors should be organized, either by local firms, joint ventures with foreign companies, public companies or a mix of foreign and local private firms [35].

In 1981, the Taiwanese government initiated the high technology and modernization plan which focused on high-technology industries, such as information, electro-optics, machinery, precision instruments, biotechnology and, later on, the civil aircraft industry [33].

Since the 1990s, technology-intensive industries in Taiwan have become increasingly important. The percentage of technology-intensive industries within the manufacturing sector rose from 24% in 1986 to 38.8% in 1997 [36]. During the same period of time, technology-intensive exports jumped from 22.2% to 54.6%.

A. Innovation and technology policies in Taiwan

The main challenge for the Taiwanese government was to upgrade from a traditional underdeveloped economy, from a condition of little know-how, inadequate institutions, and an under-supply of trained scientists and engineers to that of a high-tech based economy [8]. The key problem they faced was to keep upgrading the technological content of their products. On this regard, the policies they adopted focused on four areas: building human resources, Acquiring technology from the more advanced countries, Creating science and technology capacities, and Converting research results into commercial products [37].

Building human resources: Since the 1960s, strengthening education has been a national priority for Taiwan. The government encouraged students to go abroad for post-graduate studies. Initially, many graduates found jobs abroad, but since the late 1980s an increasing number of post-graduates returned to Taiwan [37]. Knowledge conveyed by nationals who had been educated or worked abroad became an important mode of technology transfer as industrialization proceeded and changing factor prices dictated a shift to more capital and technology intensive sectors in which products were protected by patents, employed specialized equipment, and were characterized by tacit knowledge [38].

Acquiring technology from more advanced countries: The industrial structure of Taiwan has a large number of small and medium-sized firms and a few large ones. By establishing backward linkages with materials and technology, mostly with foreign corporations, the industry slowly developed niches of advantage. This strategy was successful in developing a strong position in consumer electronics, small machineries, footwear and textiles, bicycles and other sporting goods, and remained as the most common means of acquiring technology up to the early 1990s [33]. At that time, invention was a more distant goal [34].

Creating science and technology capacities: In the early 1970s, little research was done in Taiwan. There were few researchers, limited funds and projects scattered loosely. A similar situation existed in the manufacturing industry. To change these conditions, the Industrial Technology Research Institute (ITRI) was established in 1973. This center receives contracts from the government to develop generic technologies, and transfer the results to the industries in a non-exclusive manner. It also conducts short-term R&D projects in cooperation with private organizations, generally to improve product performance and process efficiency. ITRI's research scope covers electronics and IT, machinery, biomedical and advanced materials, energy and resources and civil aerospace among others. At the end of the 1980s the government set up key research institutes and centers of excellence at the national universities of Taiwan, Tsing-Hua, Chiao-Tung, and Cheng-Kung in the fields of applied mechanics, material science, information technology and aviation and aerospace technology.

Converting research results into commercial products: In order to speed up the conversion of R&D results into commercialization, the Department of Industrial Technology (DOIT) of the Ministry of Economic Affairs, implemented the industry-institute joint research projects. Based on needs of companies with limited R&D facilities, DOIT also promotes a research-based open laboratory strategy, which gives access to companies for the purpose of maximizing existing resources and minimizing investment risks before commercialization can take place [36].

B. Science and Technology Parks in Taiwan

In order to upgrade its economy toward technology-intensive and capital-intensive industries, in July of 1979, the government enacted the Statute for the Establishment and Administration of a Science- Based Industrial Park of Taiwan. The park was established in December of 1980 in Hsinchu in order to attract high-technology companies focusing both on research and manufacturing. It started with a few companies, and today it is conformed of a complex of facilities in 6 different locations: Hsin-Hua, Jhunan, Longtan, Tongluo, Yilan and the Biomedical Park in Hsin-Hua .

According to the Statute, the HSIP was to review carefully the industries to be accepted on its grounds. Specifically, at least one of the following criteria must be met: 1) The industry should possess various design capabilities in product development and manufacturing, as well as a comprehensive plan for product development; 2) The industry should produce products with potential for development and innovation; 3) The industry should be R&D-intensive, or help to introduce and/or cultivate advanced scientists and technicians during the manufacturing process and; 4) The industry should be represented by an established research institute focusing on advanced innovative research and development. HSIP hosts mainly companies from the biotechnology, computers and peripherals, optoelectronics, precision machinery, semiconductors, and telecommunications industries. Companies located in the park receive some investment incentives and benefits due to the policies of the industrial park's management. Additionally, they get benefitted of the agglomeration effects that are generated by technological externalities of the same firms located inside the park.

V. SIMILARITIES, DIFFERENCES AND COOPERATION OPPORTUNITIES

[10] compare the innovation systems of China and Taiwan according to the roles of the main agents of the system and their interactions and propose a series of cooperation opportunities. This section summarizes their results.

According to their functions, [10] identify six roles: formulation of policies; R&D performance, R&D financing; promotion of human resource development; technology bridging and; the promotion of technological entrepreneurship. With respect to their interactions, they highlight four aspects: R&D collaboration; informal interaction; technology diffusion and; personnel mobility. Table3 summarizes their results.

Table 3. Comparison of the innovation systems of Taiwan and China

	Taiwan	**China**
Institution functions		
Policy formulation	• Consensus • Integrated planning and decentralized implementation	• Very centralized and planned • Top-to-down assigned implementation
Performing R&D	• Enterprises as the primary performer, industry dominant by SMEs • Research institutes as the role of hub • Universities as the primary performer of basic research	• Both enterprises and research institutes as the primary performers • Enterprises invest in importing technology more than in developing their own R&D capabilities • Research institutes follow government's policy and allocation • Universities as the primary performer of basic research
Financing R&D	• 2.05% of GDP • Ratio of investment: government (32.2%), industry (65.6%), private institutes (2.1%), overseas (0.1%) • Ratio of spending: industry (63.3%), research institutes (25.0%), universities (11.7%)	• 0.83% of GDP • Ratio of investment: government (32.4%), industry (34.9%), banks (8.8%) • Ratio of spending: industry (41.6%), research institutes (43.4%), universities (10.6%)
Promotion of human resource development	• 91.7 researchers per 10,000 labors • Ratio of distribution: industry (58.4%), research institutes (21.6%), universities (20.2%) • Several specific organizations are responsible for different levels of S&T personnel development	• 22 researchers per 10,000 labors • Ratio of distribution: industry (49.9%), research institutes (25.5%), universities (24.6%) • The education system and the education method restrict the nurture of students' innovative capabilities
Technology bridging	• Emphasizing direct guidance and support for specific fields of innovative technology	• Emphasizing indirect support as the basis for the construction of an innovation-related environment
Promotion of technological entrepreneurship	• Good entrepreneurship • With mature entrepreneurial infrastructure	• Poor entrepreneurship • Lacks of mature entrepreneurial infrastructure

	• Fewer entrepreneurial opportunities relatively	• Plenty of entrepreneurial opportunities relatively
Interactions of institutions		
R&D collaboration	• Government promotes R&D collaboration by offering financial support and tax deductions	• Universities are the main collaborative objects for enterprises, research institutes, and other universities
Informal interaction	• Personnel relationship network developed well • Strong and close partnership network within industry	• Inactive relationship and partnership result from the restrictions of patent system, employment system, and social culture
Technology diffusion	• Research institutes as the primary diffuser • Mechanisms: technology transfer, contract services, and spin-offs	• Innovative technologies diffuse from research institutes and universities to enterprises • Mechanisms: technology transfer contract, technology markets, and spin-offs
Personnel mobility	• Plenty of personnel move from research institutes to industry • Returnees with work experience from abroad increasing	• Inactive personnel mobility results from planned employment system and restrictive social culture • Returnees from abroad increasing

Source: Chang and Shih, 2004).

The Taiwanese economy, falls under the small-economy high-income category of the [39], on which countries need to internationalize faster and to reduce the range of priority industries in order to get the most benefits of that openness process. These countries usually benefit from technology inflows, but only limited to a small range of fields [39]. On the other hand, China's innovation system fits into the large catching-up economies, which offer large markets with poor customers. On these countries, R&D intensity and innovative activity tends to be very low. They are usually focused on technology transfer, adoption and diffusion [39].

The advantage of Taiwan's innovation system over the Chinese resides on the efficiency of the interactions among the main agents of the system, especially on the informal relationships. However, as Taiwanese companies tend to be small, they are very dependent on inflows of foreign technology [10] and subject to the global economic fluctuations. On the other hand, the Chinese government is the major financer of R&D, and this expenditure is still below the 1% of the GDP. As a consequence, China still remains focused on low and medium-technology industries [10]. In order to develop technology, China still needs to import it and then concentrate on its transference. Based on this analysis, [37] propose a series of cooperation opportunities among China and Taiwan: 1) the size of the Chinese market could fill Taiwan's need for internationalization; 2) Taiwanese investment could provide a way to import technology and renew the transfer, adoption and diffusion process in China; 3) Chine provides plenty of entrepreneurial opportunities that can't be fully developed because of a poor entrepreneurial eco-system. Taiwan possesses a very mature incubation and venture capital industry with plenty of entrepreneurs.

VI. CONCLUSIONS AND AFTERTHOUGHTS

The importance of innovation policies for economic development has been reflected systematically in the literature through the approach of national innovation systems. A NIS is a system of interactions between various actors that are coordinated through a series of regulations and policies that aim to promote innovation and technology development. Each nation has developed its NIS based on their own needs and conditions, and these have evolved over time.

In this paper the evolution of the Chinese and Taiwanese NIS was presented. These two countries have many historical, cultural and economic connections. However they have almost opposite conditions: Taiwan is a relatively small island, while

China is the world's most populous nation. Taiwan is a developed country, classified under the category of high-income nations, while China's per capita income does not exceed $900 USD per year. In addition, Taiwan has been able to develop high technology in a very specific set of industries, while China is still in a stage of import, transfer, adoption and diffusion of technology, and therefore, it is still very concentrated in industries of low to medium technology.

In both countries, government intervention in the enactment, implementation and enforcement of policies of innovation has been fundamental. While China's economic development has been centrally planned by the government and its interference remains very important in the development of innovation policies, the results that have been obtained are prominent. In the case of Taiwan, with a more liberalized economic system, the government has raised the general guidelines and provided the infrastructure on which it has developed a system for successful innovation and technological development.

This paper presented the differences and similarities of the NIS in Taiwan and China and the collaboration opportunities they offer. This verifies that while innovation policies need to be formulated on the basis of site-specific conditions, it is possible to identify similar patterns in the evolutionary process of these in several countries. An integrative approach, however, remains for future work. On the other hand, by being able to identify the different conditions and stages of NIS', it is possible to find opportunities for complementarities and cooperation between different countries (regions, industries) to develop markets, generate new technology and allocate resources more efficiently beyond frontiers.

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Author:

Tonatiuh Najera is with the SolBridge International School of Business, Korea.